



Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure and the  
Environment*

# **Retrieval of Aerosol Height with TROPOMI**

Bram Sanders

&

J. de Haan, M. Sneep, D. Stein, J. van Geffen,  
P. Veefkind

*TROPOMI L2 Algorithm Team*



# Overview

- Introduction of the aerosol height product
- Sensitivity analyses:
  - phase function
  - single scattering albedo



# TROPOMI aerosol products

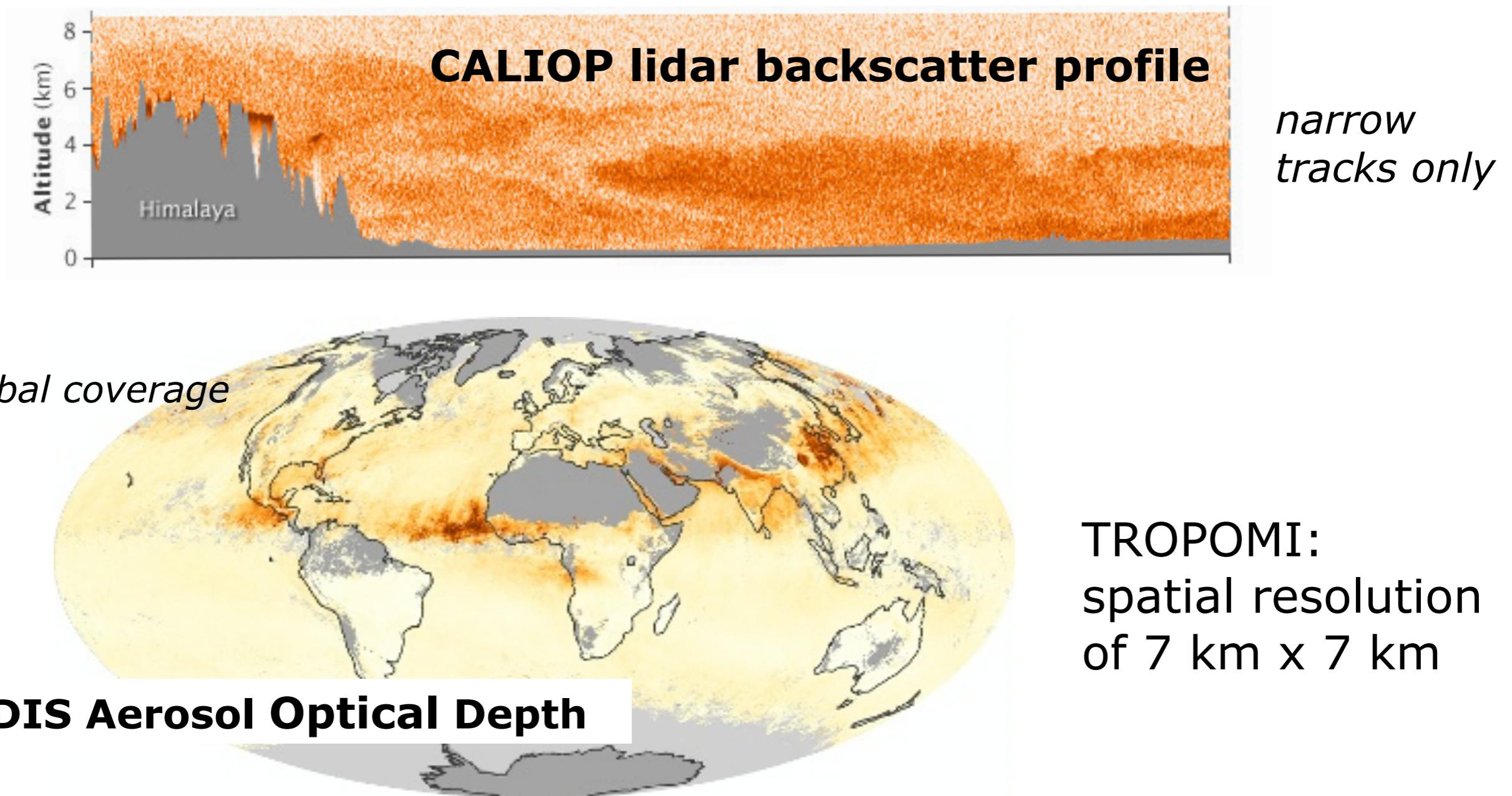
**Absorbing  
Aerosol  
Index**

**Aerosol  
Layer  
Height**

**Aerosol  
Optical  
Thickness  
& Type**

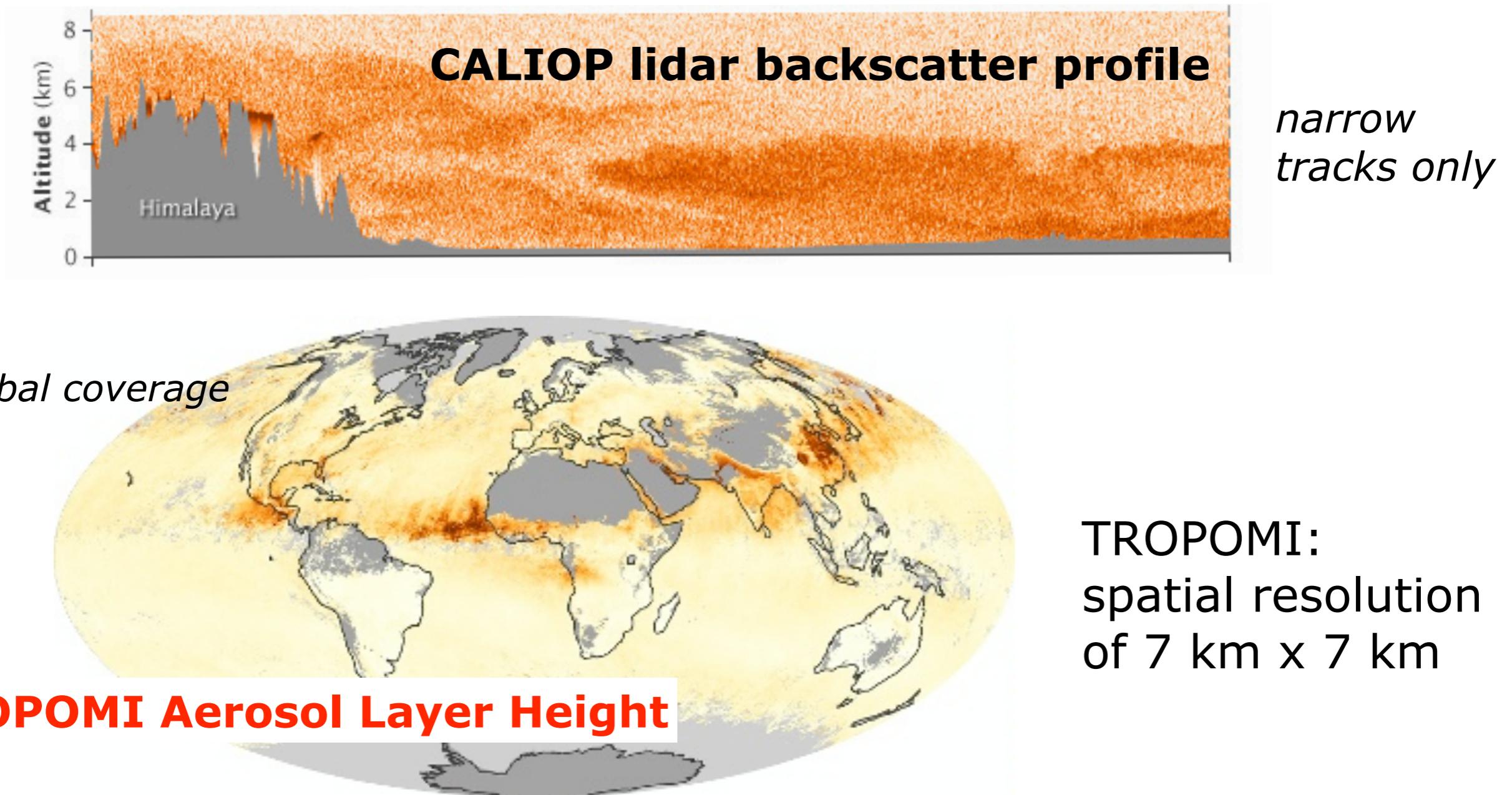


# TROPOMI: Daily global coverage



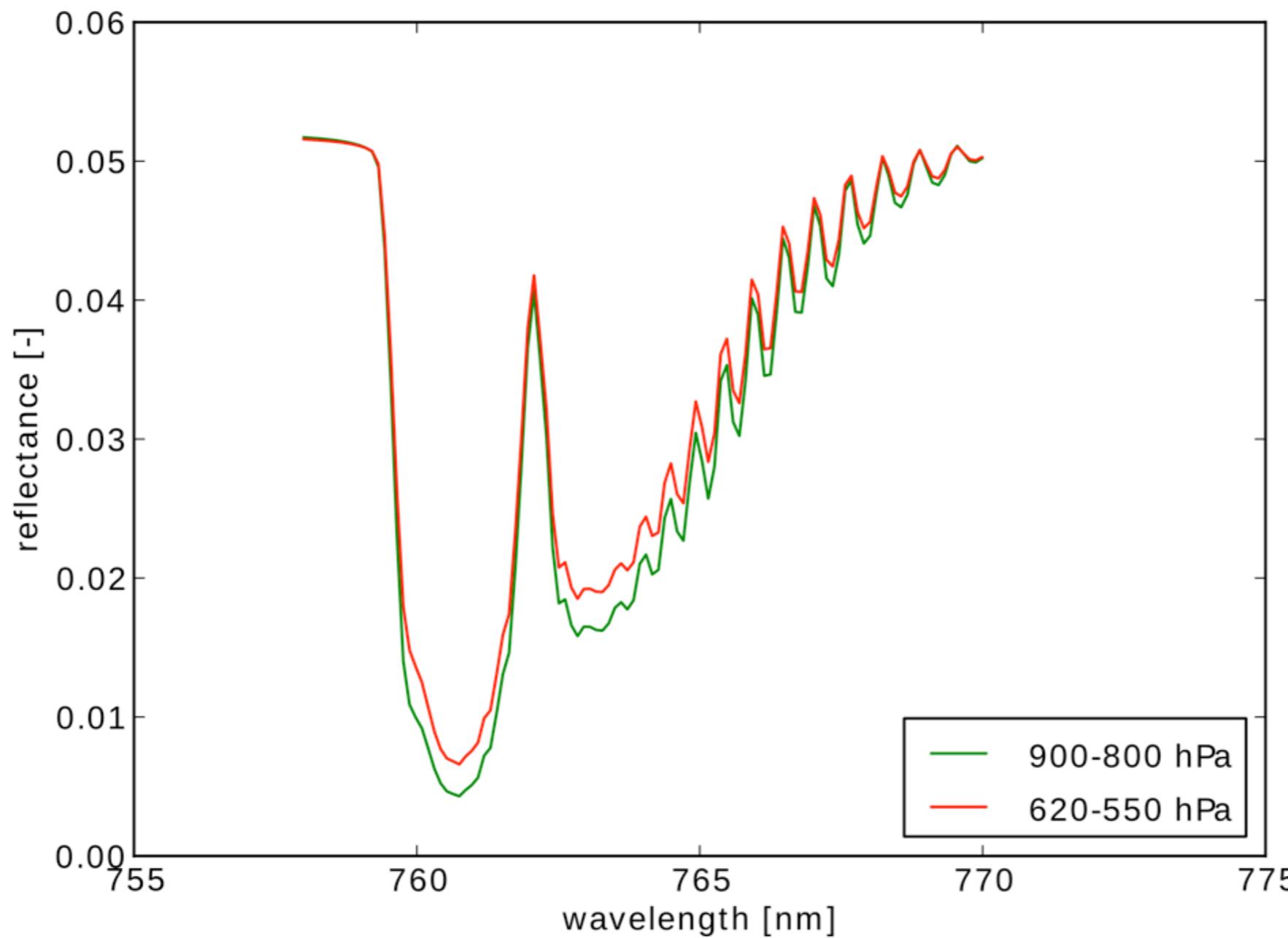


# TROPOMI: Daily global coverage





# Height retrieval using O<sub>2</sub> A-band



TROPOMI:  
spectral  
resolution  
of 0.5 nm



# Operational Aerosol Height Retrieval

- Spectral fit of reflectance at wavelengths  $\sim 758\text{-}770 \text{ nm}$ :  
fit parameters are ALH, AOT,  $A_s$ , ...
- Optimal Estimation: proper error analysis
- Further improvements in forward model:  
P-T profiles, spectroscopic data, fluorescence...



**DISAMAR**

---

**J.F. de Haan**

## Determining Instrument Specifications and Analyzing Methods for Atmospheric Retrieval

Software package that can

- simulate *measured* backscattered radiances and
- apply different types of retrieval algorithms.

Used to investigate the sensitivity of L2 products to

- the forward model,
- the retrieval method and
- measurement errors.



## Central Question

*How well do we need to know the particular aerosol optical properties in order to retrieve its height accurately and precisely enough?*



## Central Question

*How well do we need to know the particular aerosol optical properties in order to retrieve its height accurately and precisely enough?*

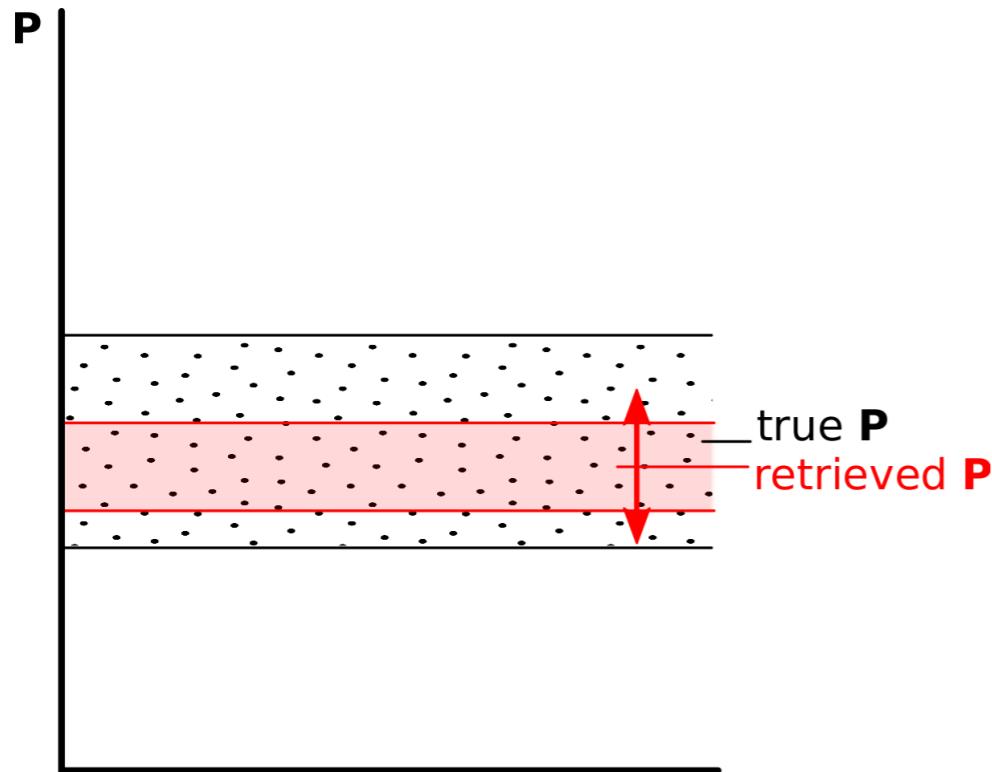
Target science requirement of 50 hPa (0.5 km)



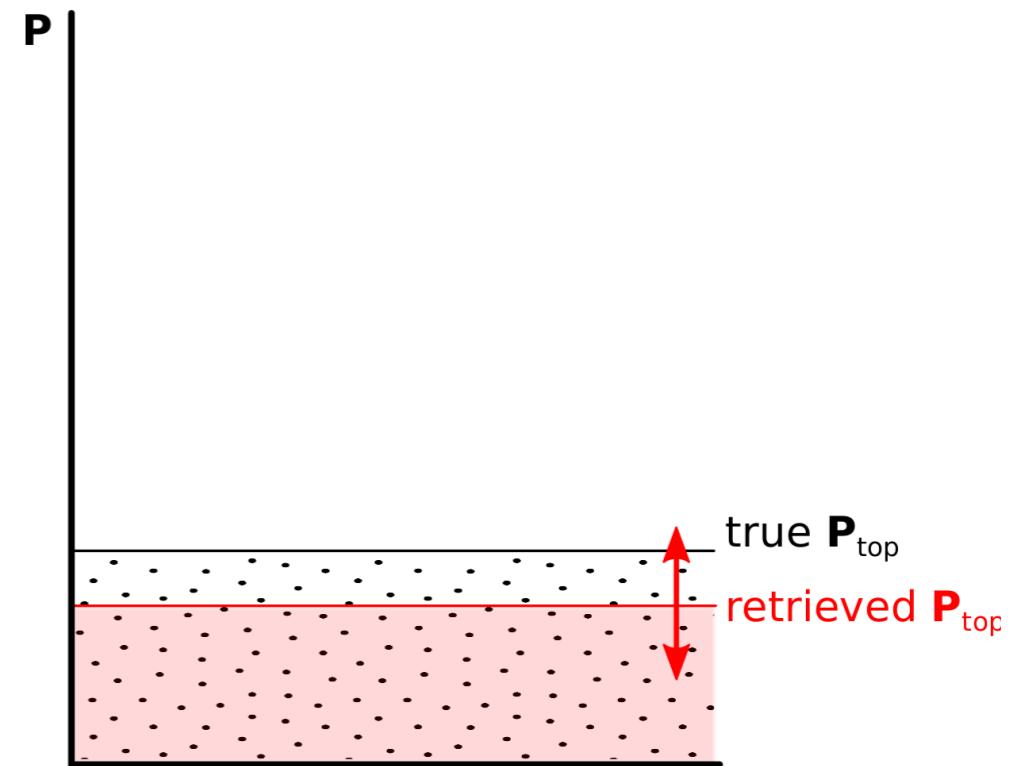
# Sensitivity analysis: Phase function

true: phase function from Mie calculations  
retrieval: Henyey-Greenstein phase function

(i) Dust over dark sea



(ii) Weakly absorbing over bright land



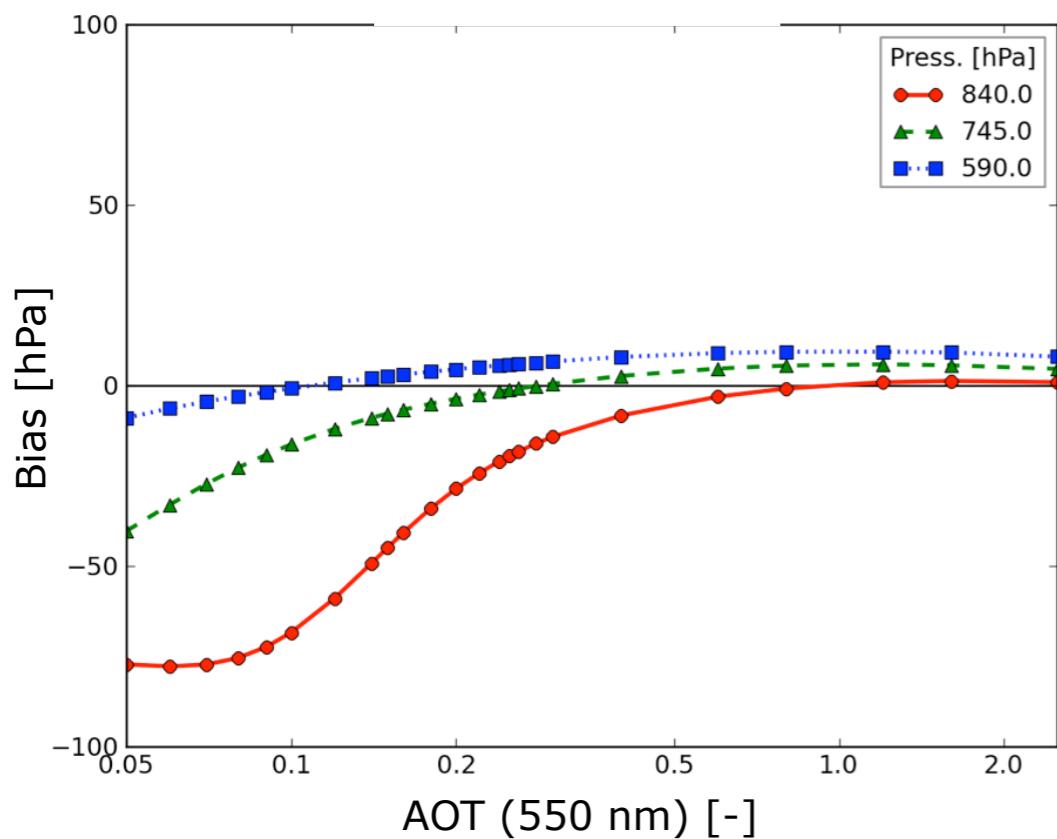
(aerosol models from *Aerosol Climate Change Initiative-project*)



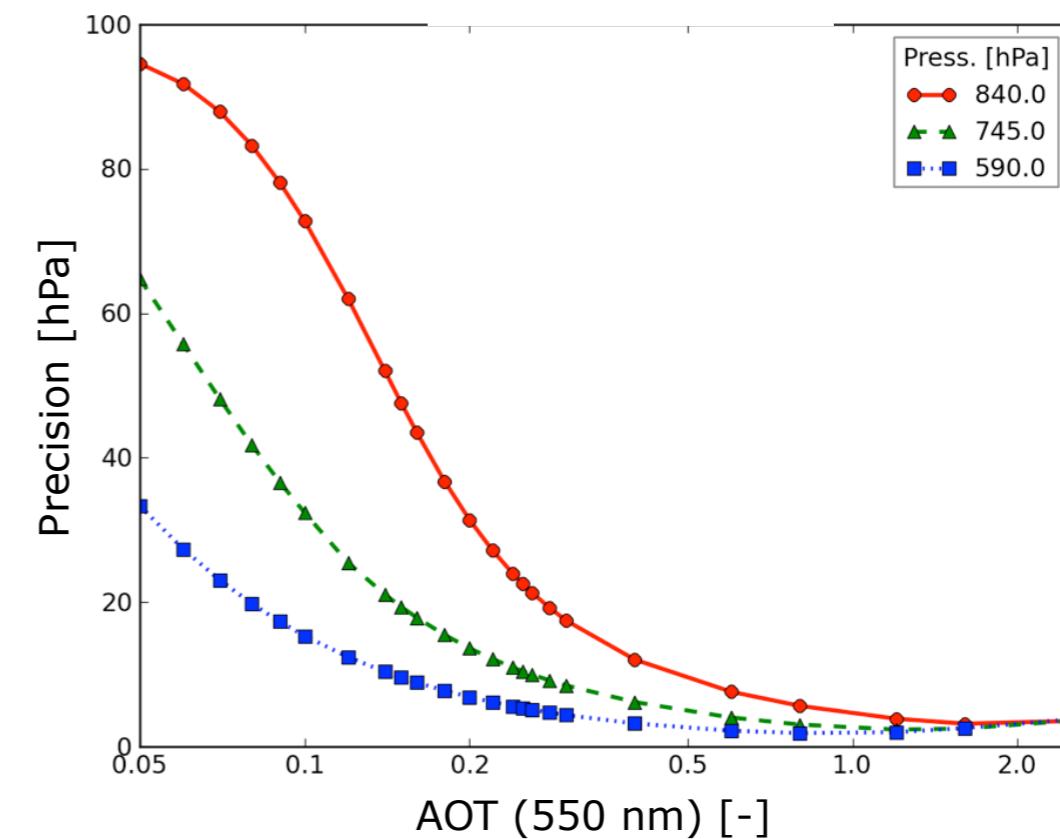
# Dust over sea

fit: **P, AOT, SSA, As**

Bias (retrieved - true)



Precision ( $\sigma$ )

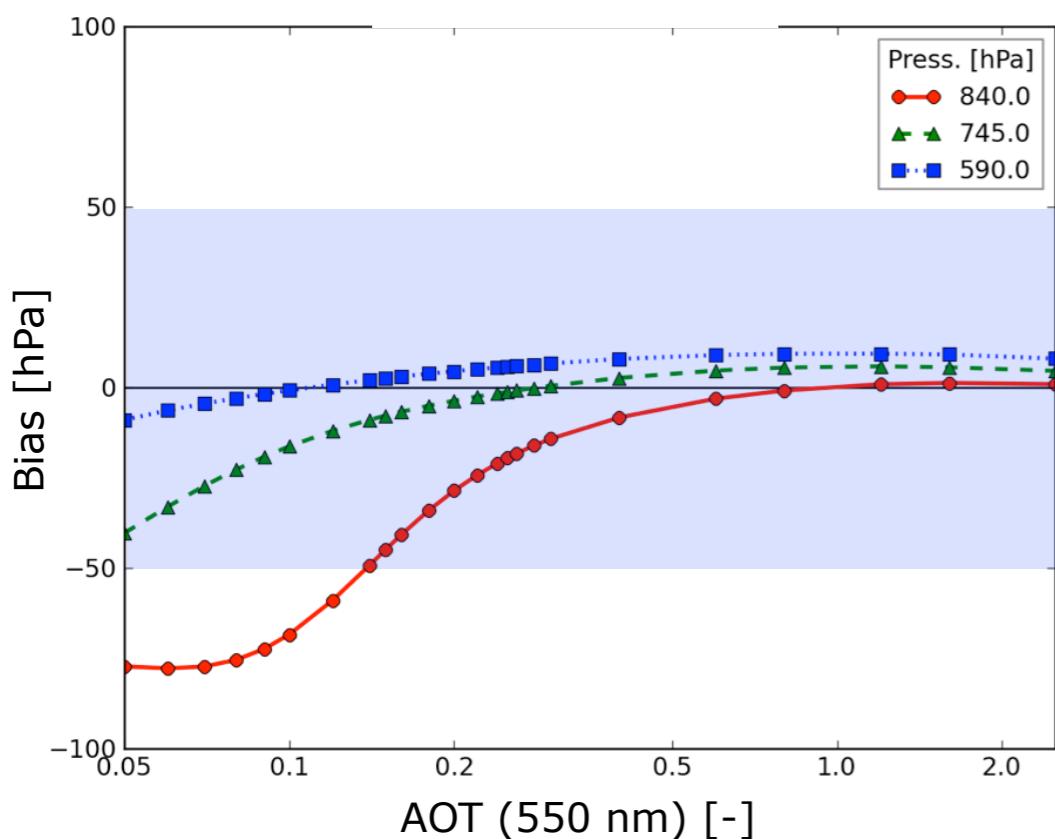




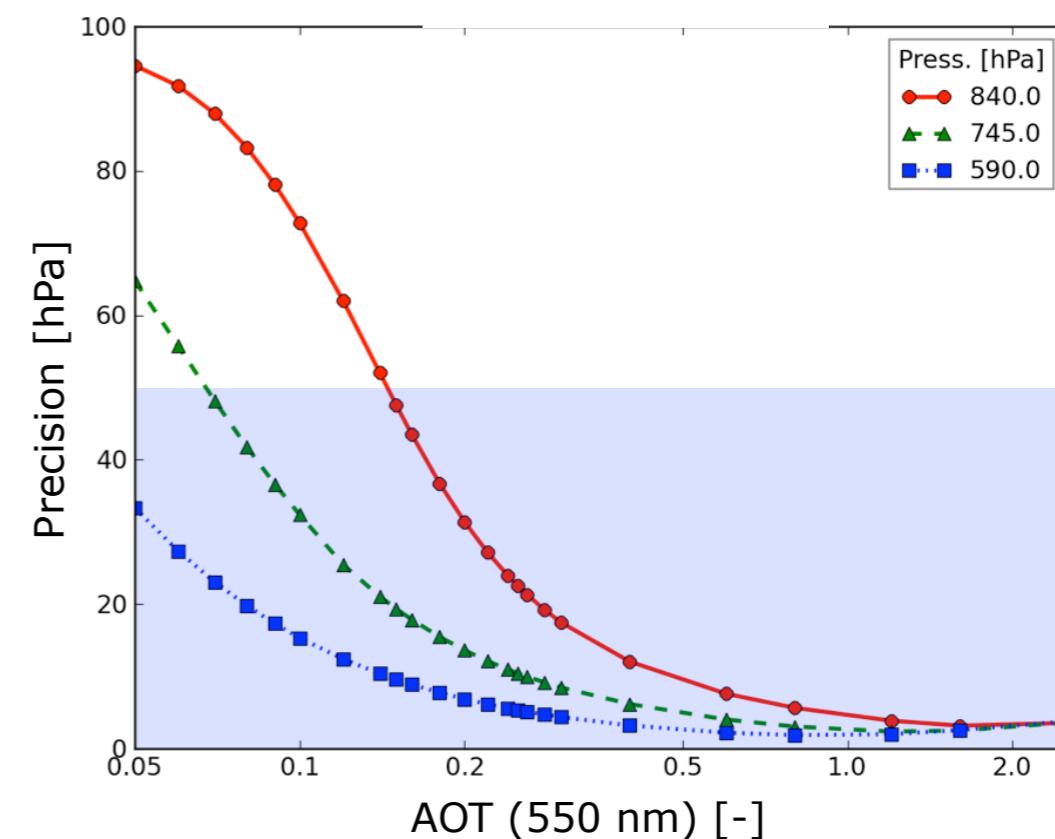
# Dust over sea

fit: **P, AOT, SSA, As**

Bias (retrieved - true)



Precision ( $\sigma$ )



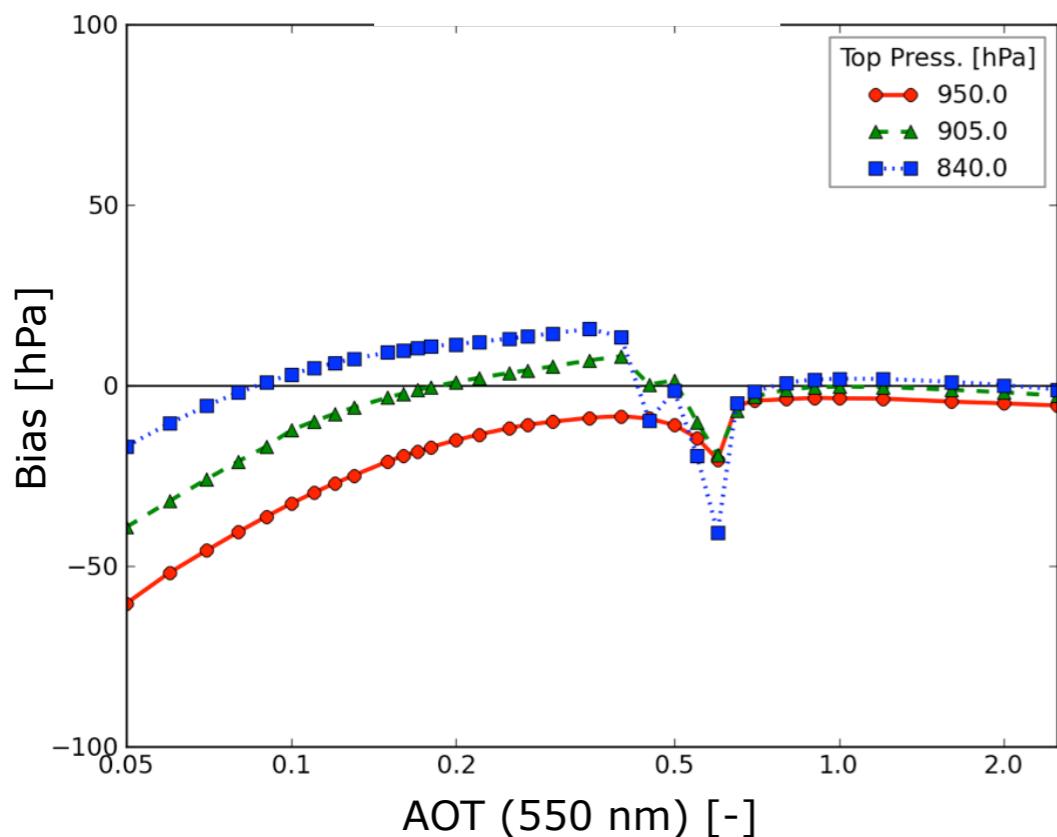
→ For  $AOT > 0.1-0.2$ , accuracy and precision of retrieved height below 50 hPa (500 m).



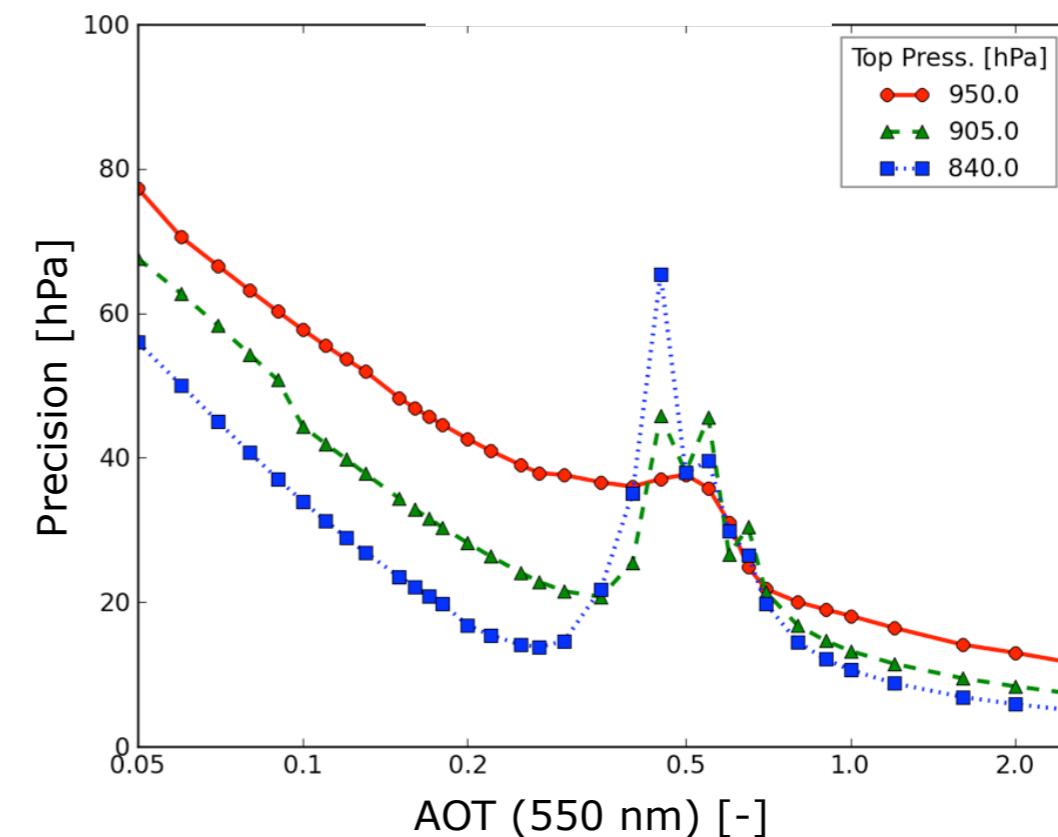
# Weakly absorbing over land

fit: **P, AOT, As**

Bias (retrieved - true)



Precision ( $\sigma$ )

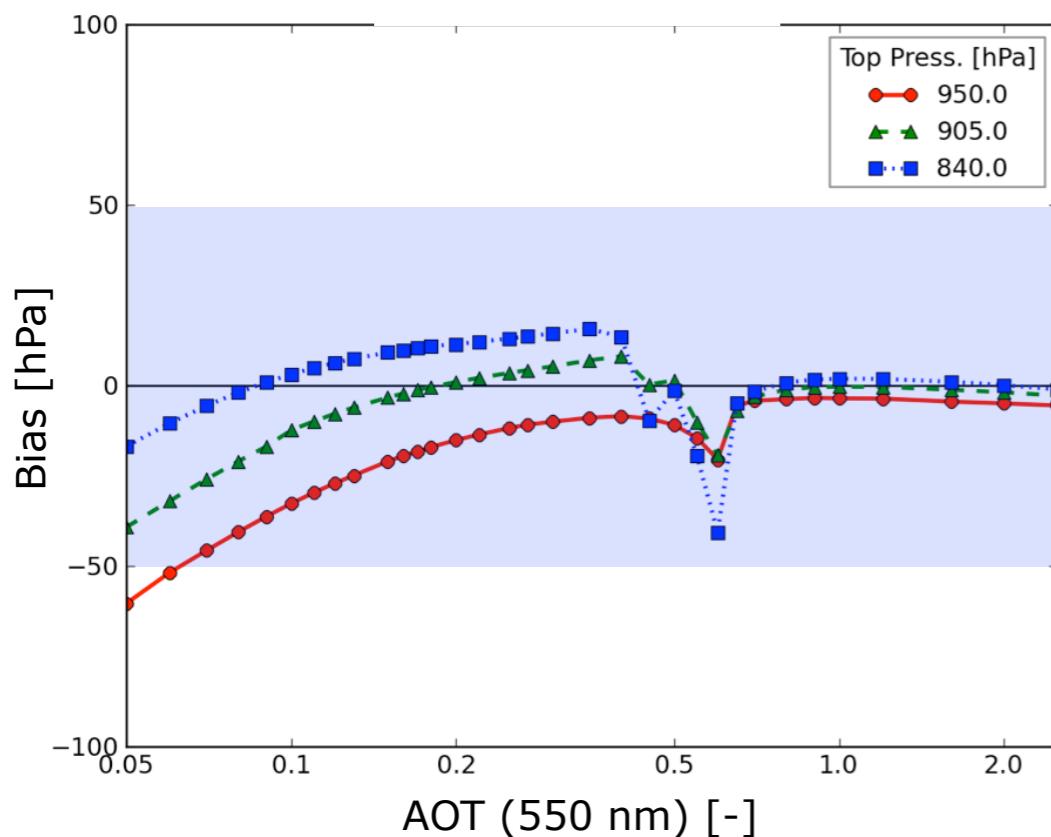




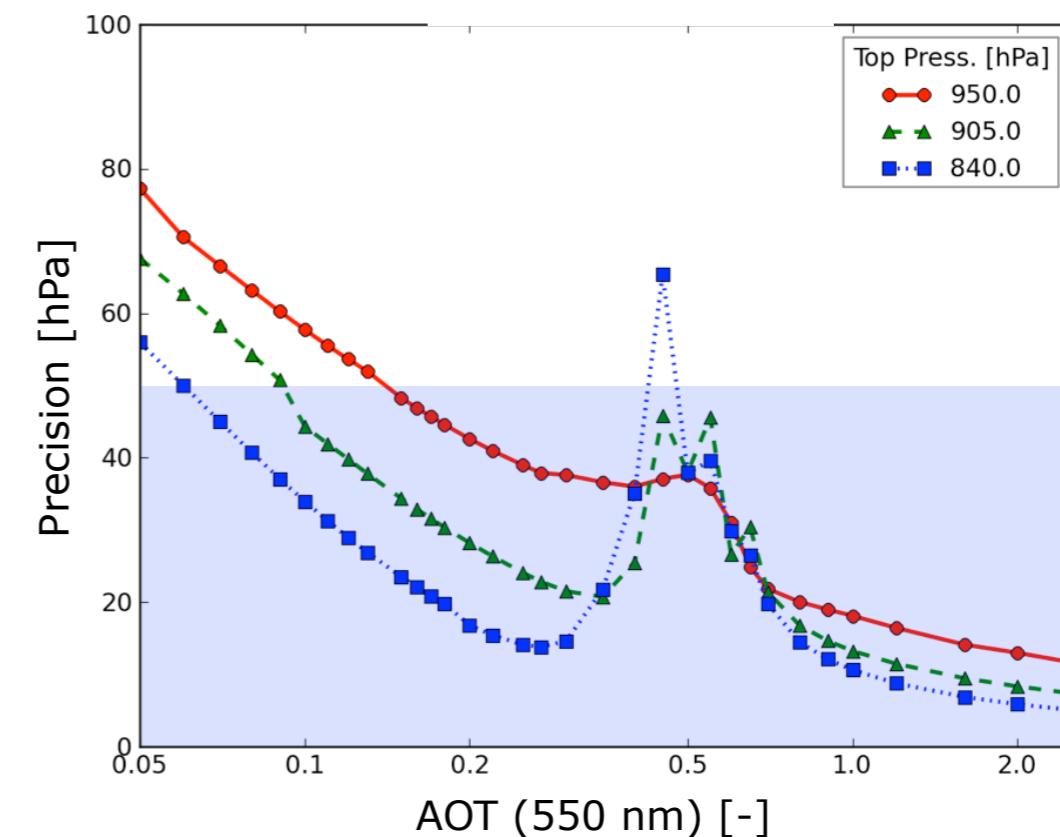
# Weakly absorbing over land

fit: **P, AOT, As**

Bias (retrieved - true)



Precision ( $\sigma$ )



→ For  $AOT > 0.1-0.2$ , accuracy and precision of retrieved height below 50 hPa (500 m).

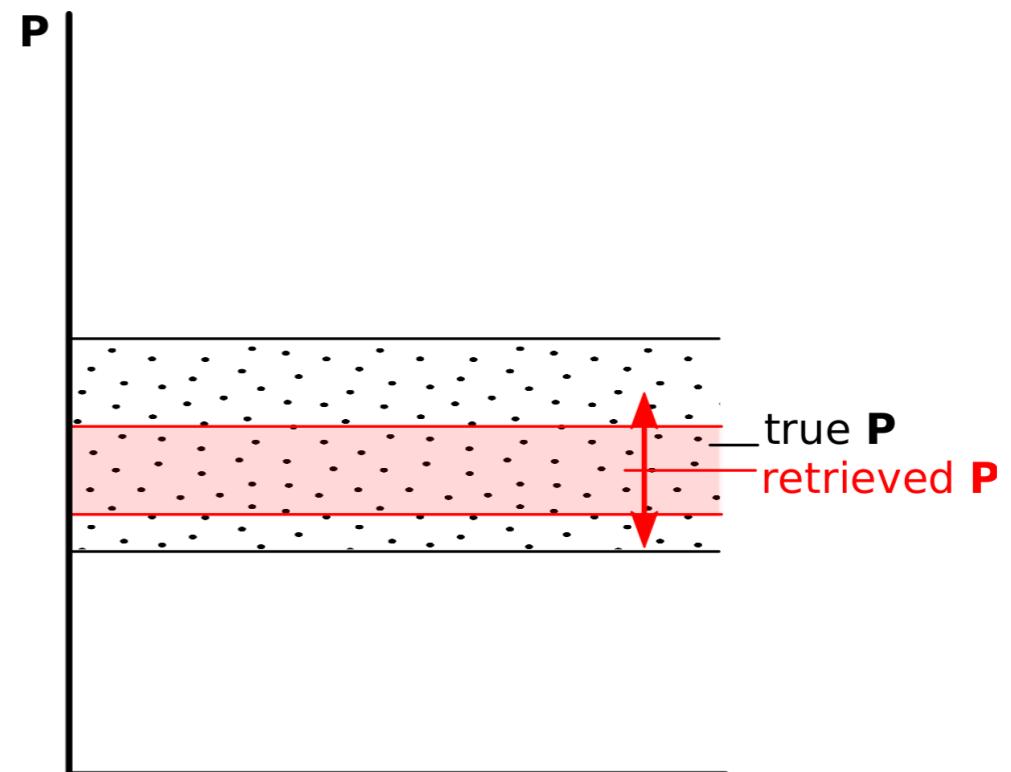


# Sensitivity analysis: Single Scattering Albedo

true: SSA 0.90 or 1.0  
retrieval: SSA 0.95

Same HG phase function in simulation and retrieval ( $g = 0.7$ )

Dark sea surface

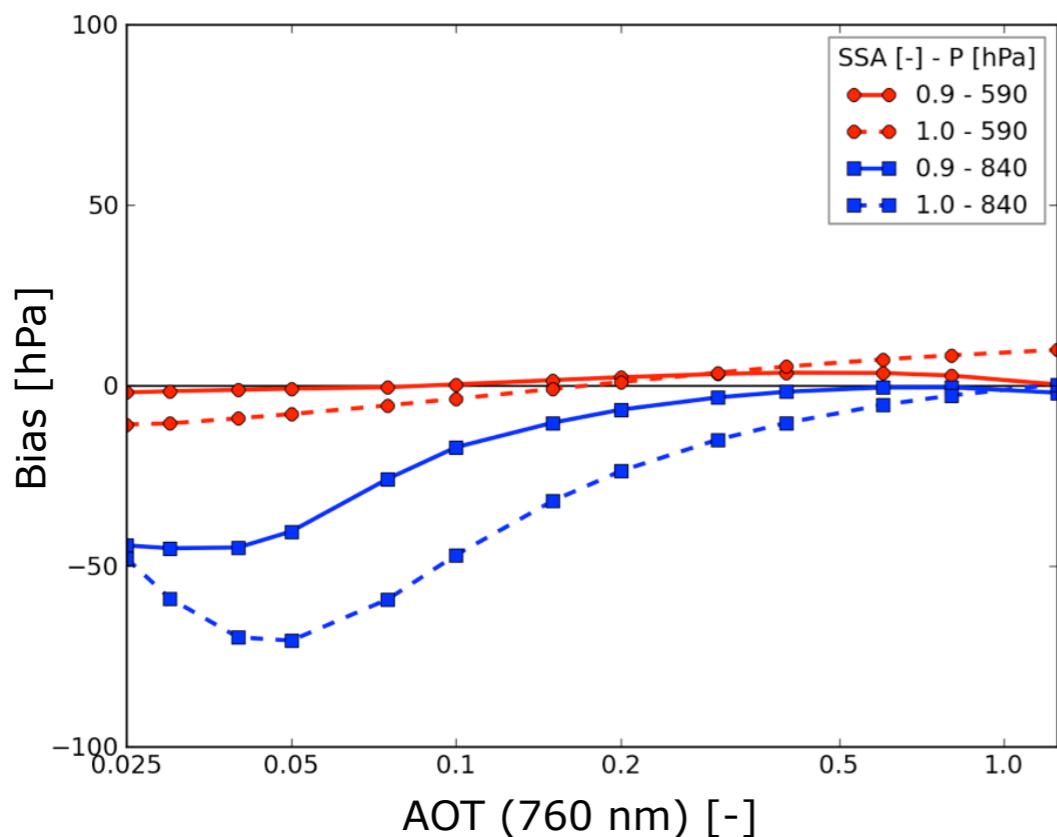




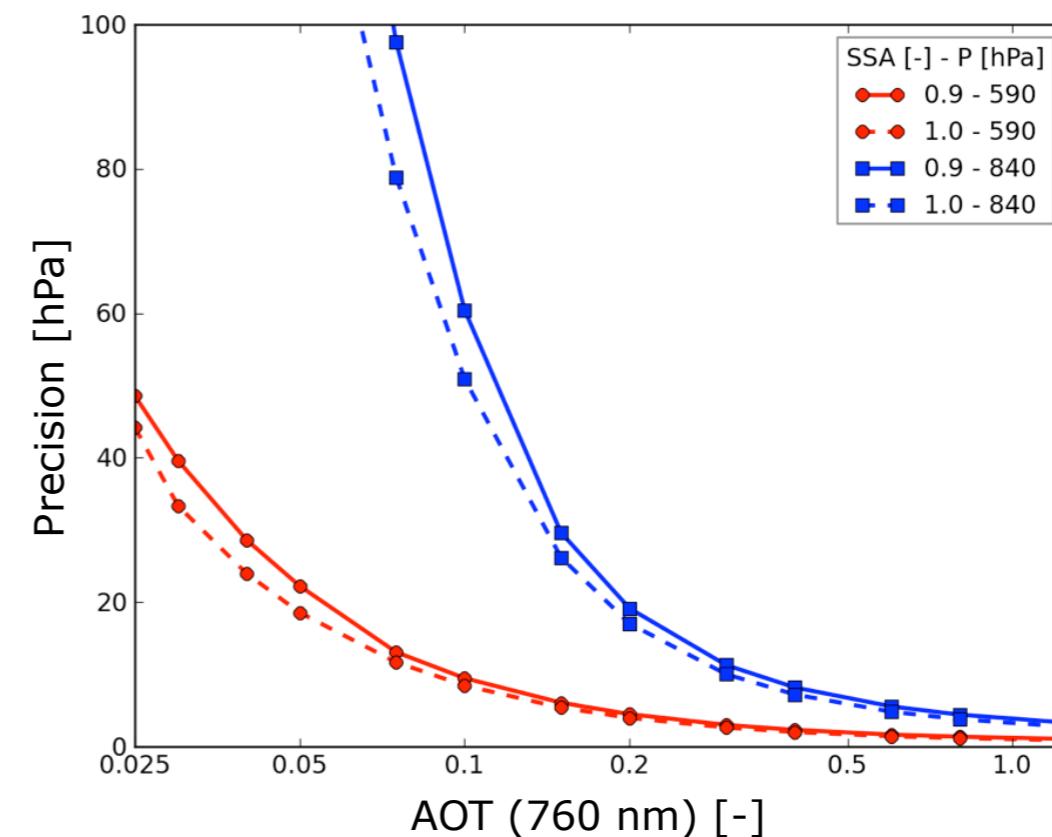
# Single scattering albedo

fit: **P, AOT,  $A_s$**

Bias (retrieved - true)



Precision ( $\sigma$ )

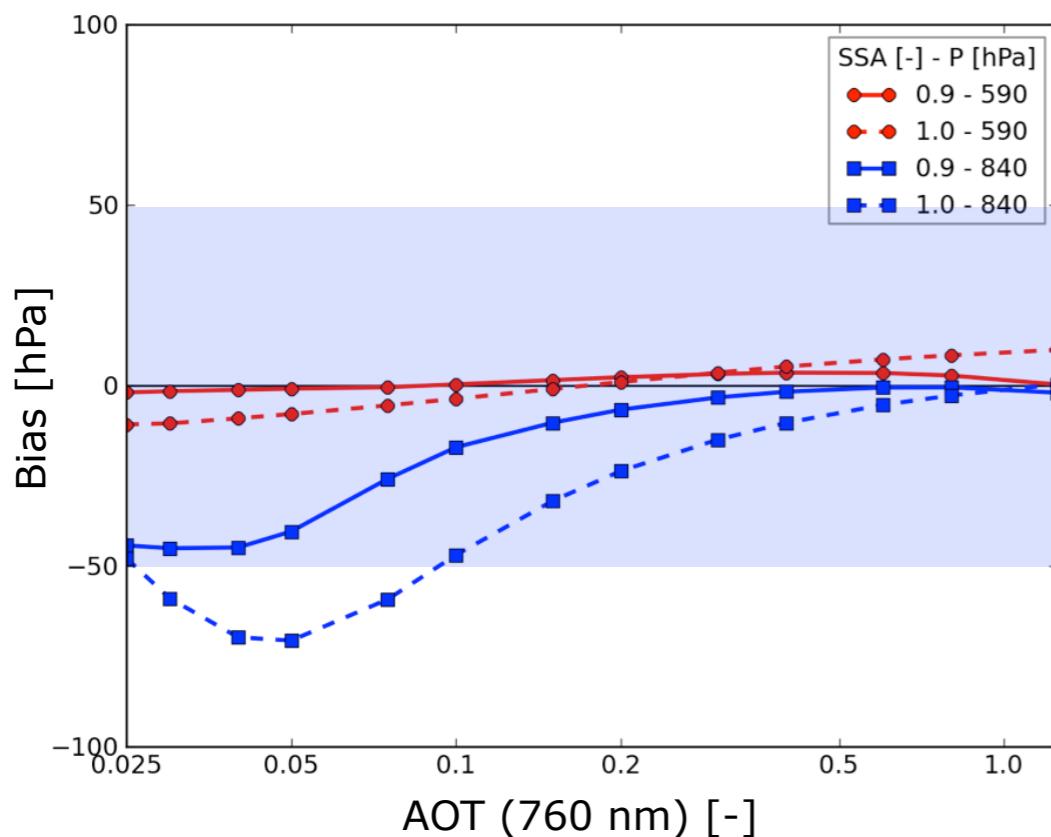




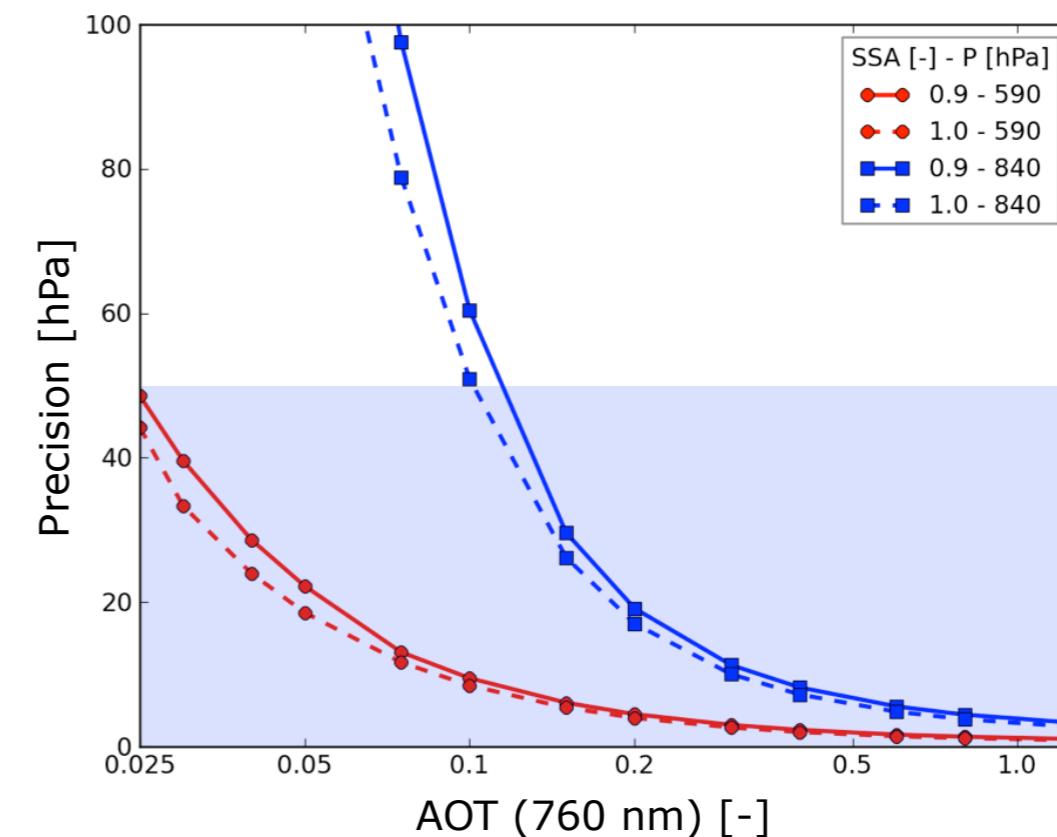
# Single scattering albedo

fit: **P, AOT,  $A_s$**

Bias (retrieved - true)



Precision ( $\sigma$ )



→ For  $AOT (760 \text{ nm}) > \sim 0.1$ , accuracy and precision of retrieved height below 50 hPa (500 m).



## Conclusions

- Accuracy and precision of retrieved height below ~50 hPa (.5 km) for aerosol layers with AOTs larger than 0.2, particularly for elevated layers.
- Henyey-Greenstein phase function can be used for faster retrieval.
- Retrieval robust against inaccurate knowledge of the SSA.

## Future work

- Computation time & Convergence
- Cirrus contamination